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IRON ORES - DETERMINATION OF NICKEL AND CHROMIUM CONTENTS - ATOMIC ABSORPTION SPECTROMETRIC METHOD STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - STAGE A - 1982

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Analytical Methodology

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IRON ORES - DETERMINATION OF NICKEL AND CHROMIUM CONTENTS - ATOMIC ABSORPTION SPECTROMETRIC METHOD

STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - STAGE A - 1982

by

R. Sutarno* and W.S. Bowman**

SUMMARY

The analytical data collected from the international test - stage A conducted by ISO/TC 102/SC 2/WG 21A on the determination of nickel and chromium in iron ores by atomic absorption during the period 1980-1982 have been statistically evaluated to estimate the precision of the method.

The preliminary estimates of the precision can be expressed in terms of the concentration level by the following equations:

Ni - r	= 0.0339 x + 0.0005	Cr - r	= 0.0947 x + 0.0000
P	= 0.0591 x + 0.0013	P	= 0.6461 x - 0.0033
σ_r	= 0.0121 x + 0.0002	σ_r	= 0.0335 x + 0.0000
σ_L	= 0.0195 x + 0.0004	σ_L	= 0.2274 x - 0.0012

where r is the repeatability, P is the permissible tolerance, σ_r is the within-laboratories standard deviation and σ_L is the between-laboratories standard deviation.

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ISO/TC 102/SC 2 (WG 12-6)

Août 1982

MINERAIS DE FER - DÉTERMINATION DES TENEURS EN NICKEL ET EN CHROME - ANALYSE STATISTIQUE DES DONNÉES D'ESSAIS INTERNATIONAUX OBTENUES PAR LA MÉTHODE SPÉCTROMÉTRIQUE D'ABSORPTION ATOMIQUE

par

R. Sutarno* et W.S. Bowman**

RÉSUMÉ

Les données analytiques recueillies lors de l'étape A des essais internationaux effectués par ISO/TC 102/SC 2/WG 21A sur la détermination des teneurs en nickel et en chrome des minerais de fer, pendant la période 1980-1982, ont été évaluées statistiquement dans le but d'estimer la précision de la méthode spectrométrique d'absorption atomique.

Les premières estimations de la précision peuvent être exprimées en fonction de la concentration par les équations suivantes:

Ni	Cr
$r = 0{,}0339\ x + 0{,}0005$	$r = 0{,}0947\ x + 0{,}0000$
$P = 0{,}0591\ x + 0{,}0013$	$P = 0{,}6461\ x - 0{,}0033$
$\sigma_r = 0{,}0121\ x + 0{,}0002$	$\sigma_r = 0{,}0335\ x + 0{,}0000$
$\sigma_L = 0{,}0195\ x + 0{,}0004$	$\sigma_L = 0{,}2274\ x - 0{,}0012$

où r est la répétabilité, P est la tolérance admissible, σ_r est l'écart-type à l'intérieur des laboratoires et σ_L est l'écart-type entre les laboratoires.

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INTRODUCTION

At the tenth meeting of ISO/TC 102/SC 2, the sub-committee decided to undertake the development of a standard method for the determination of Ni and Cr in iron ores. The suggested concentration range was from 0.003 to 0.5% for both elements. A working group (WG 21A) was formed under the convenership of Dr. K. Kawamura of Japan with the participation of France, Germany, Italy, Japan and South Africa (1). An international test was conducted by the working group during the period 1980-1982 using three iron ore samples. Thirteen laboratories participated in this international test. The analytical results from this test were evaluated to obtain the preliminary estimates of the precision and accuracy of the analytical method.

PRINCIPLE OF THE ANALYTICAL METHOD

The test portion is decomposed and silica removed by treatment with hydrochloric and hydrofluoric acids. Fe(II) is oxidized to Fe(III) by treatment with nitric acid.

After addition of hydrochloric acid, the solution evaporated to dryness followed by dilution, and filtration. The insoluble residue is ignited and fused with sodium carbonate. The cooled melt is dissolved with hydrochloric acid.

Iron is removed from the filtrate by MIKB extraction and Ni/Cr are extracted together with iron. The MIBK is decomposed by treatment with nitric acid. After evaporation to dryness, the salts are dissolved with hydrochloric acid. The solution is combined with the residue solution and diluted to volume.

The nickel/chromium content of the solution is measured by atomic absorption spectrometry using an air-acetylene flame for nickel and a nitrous oxide/acetylene flame for chromium.

PROCEDURE OF STATISTICAL EVALUATION

The analytical data collected by Working Group (WG) 21A from the international test conducted during the period 1980-1982 were statistically evaluated by the procedure described in document ISO/TC 102/SC 2 N 532 E (2). Because each participating laboratory analyzed only one bottle of each sample, as required by WG stage A, the two-way ANOVA part of the procedure was bypassed. No confirmation on sample homogeneity could be made; thus the between-laboratories variance may include the between-bottles variation, if any, of the sample. This procedure is illustrated schematically in Figure 1 and details are given in Appendix A.

The raw data are also plotted in Figures 2. The boxed points in these figures signify that the data were suspected outliers and were excluded from the estimation of the grand means and the precisions. The precisions estimated are plotted against their corresponding grand means in Figure 3. Although only three samples were analyzed, because of the dependency of the precision with the grand means shown in Figure 3, the regression equations of these precisions were also computed. It should be borne in mind that these equations are very rough approximations.

DISCUSSION

Table 1 shows that the within-laboratory precision is probably acceptable. In terms of its standard deviation, they are in the order of

6% or less of the concentration of the elements. However, the between-laboratories variations for some samples (i.e., sample 81-6 for Cr and 79-6 for Ni) are rather high. Better standardization of the analytical method is therefore necessary. Figures 3 show that for both Ni and Cr, the precisions, particularly σ_L, are dependent on the level. This implies that the future international test should use more test samples. Figures 2 show that the number of outliers are reasonable.

REFERENCES

1 - "Final report of the tenth meeting of ISO/TC 102/SC 2 - Iron Ores/ Chemical Analysis, Pretoria, South Africa, October 1980"; ISO/TC 102/ SC 2 N 655 E; August 1981.

2 - "Procedure for statistical evaluation of analytical data resulting in international tests"; ISO/TC 102/SC 2 (WG-7-21) N 532 E; August 1978.

Table 1 - Ni

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL

SUMMARY OF PRECISIONS FOR ALL SAMPLES

SAMPLE	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L
79-6	.0019	.0003	.0014	.00012	.00047
76-17	.0477	.0020	.0041	.00072	.00135
81-6	.0167	.0015	.0022	.00052	.00070

THE REGRESSION EQUATIONS ARE:					CORR. COEFF.
R	=	.0339 X	+	.0005	.9206
P	=	.0591 X	+	.0013	1.0000
SIGMA-R	=	.0121 X	+	.0002	.9240
SIGMA-L	=	.0195 X	+	.0004	.9978

Table 1 - Cr

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM

SUMMARY OF PRECISIONS FOR ALL SAMPLES

SAMPLE	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L
79-6	.0036	.0005	.0007	.00017	.00022
76-17	.0122	.0010	.0026	.00034	.00088
81-6	.0530	.0050	.0313	.00178	.01098

THE REGRESSION EQUATIONS ARE:					CORR. COEFF.
R	=	.0947 X	+	-.0000	.9979
P	=	.6461 X	+	-.0033	.9941
SIGMA-R	=	.0335 X	+	-.0000	.9978
SIGMA-L	=	.2274 X	+	-.0012	.9941

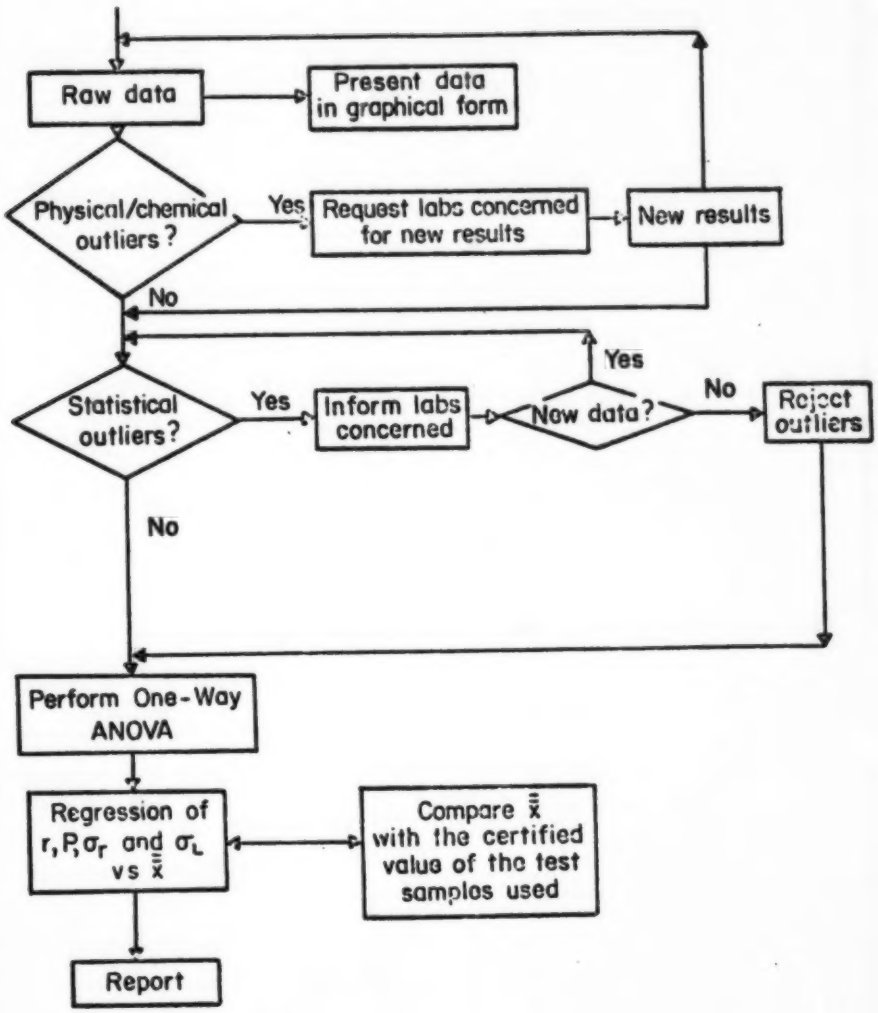

Figure 1. Flow Chart of the Procedure for Statistical Evaluation of Analytical Data Resulting from International Tests.

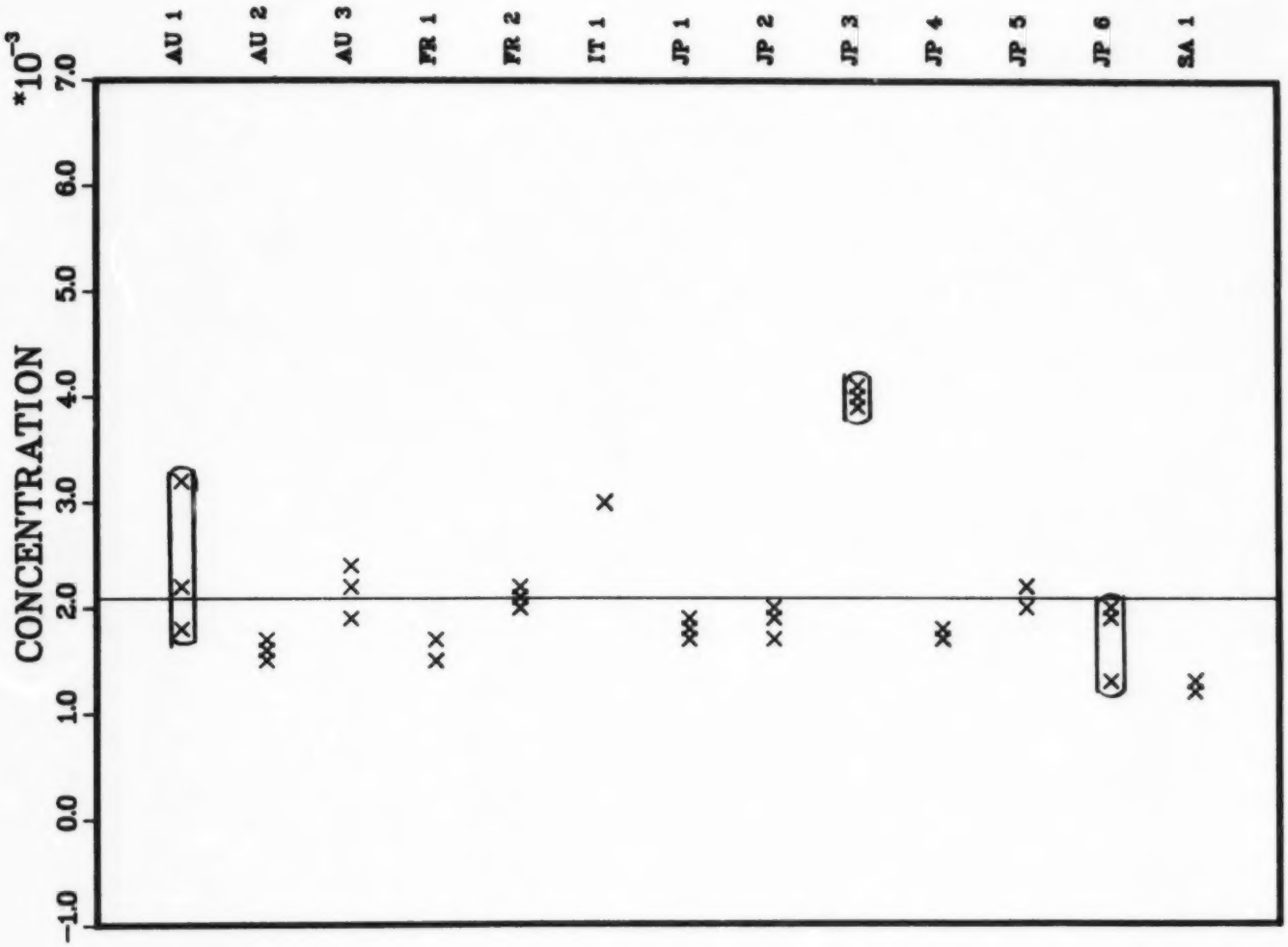

Figure 2.1 - Ni ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 79-6 (HAMERSLEY)

Figure 2.2 - Ni ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE 76-17 (SAVAGE RIVER)

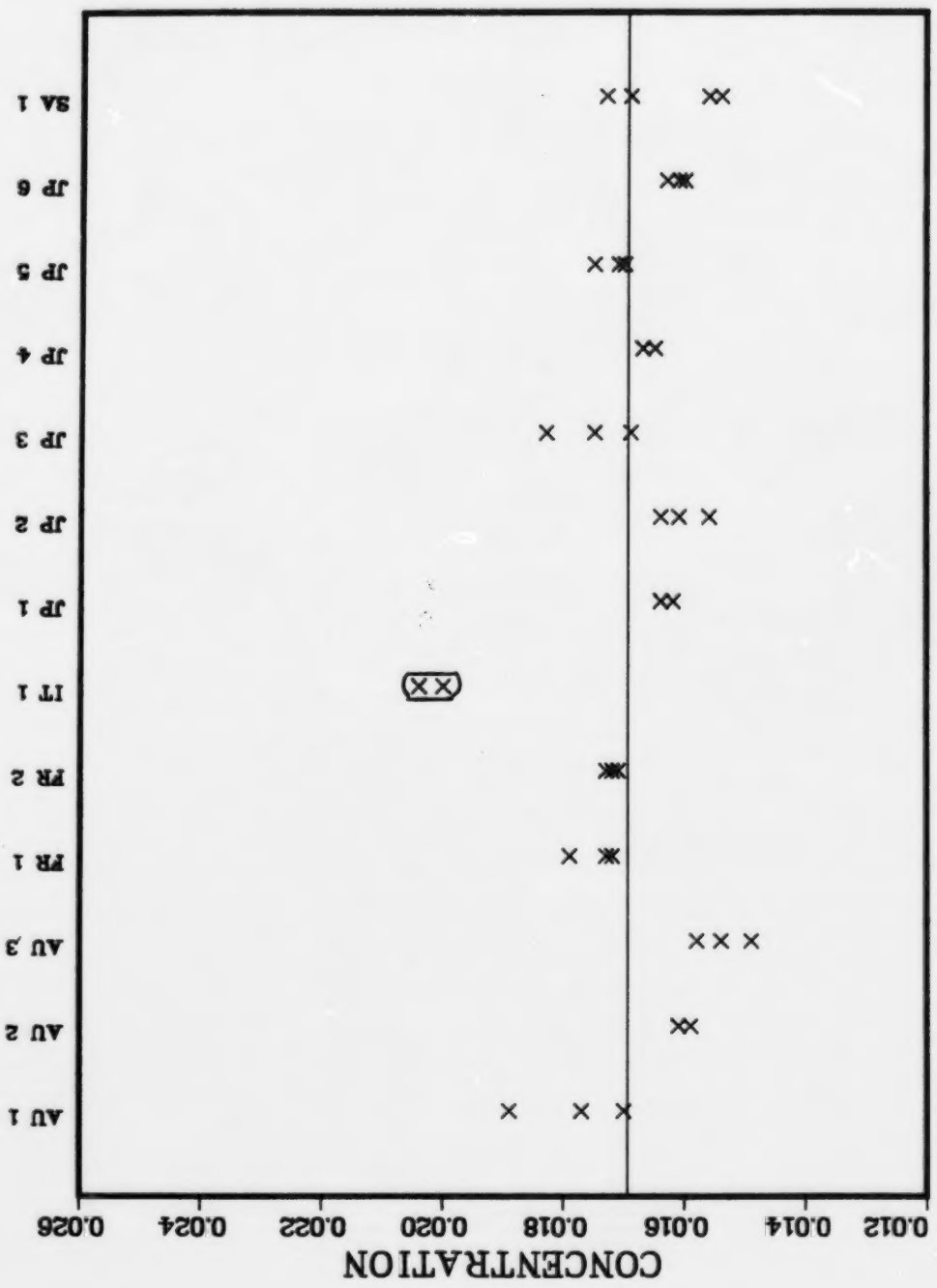

Figure 2.3 - Ni ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 81-6 (SWAZILAND)

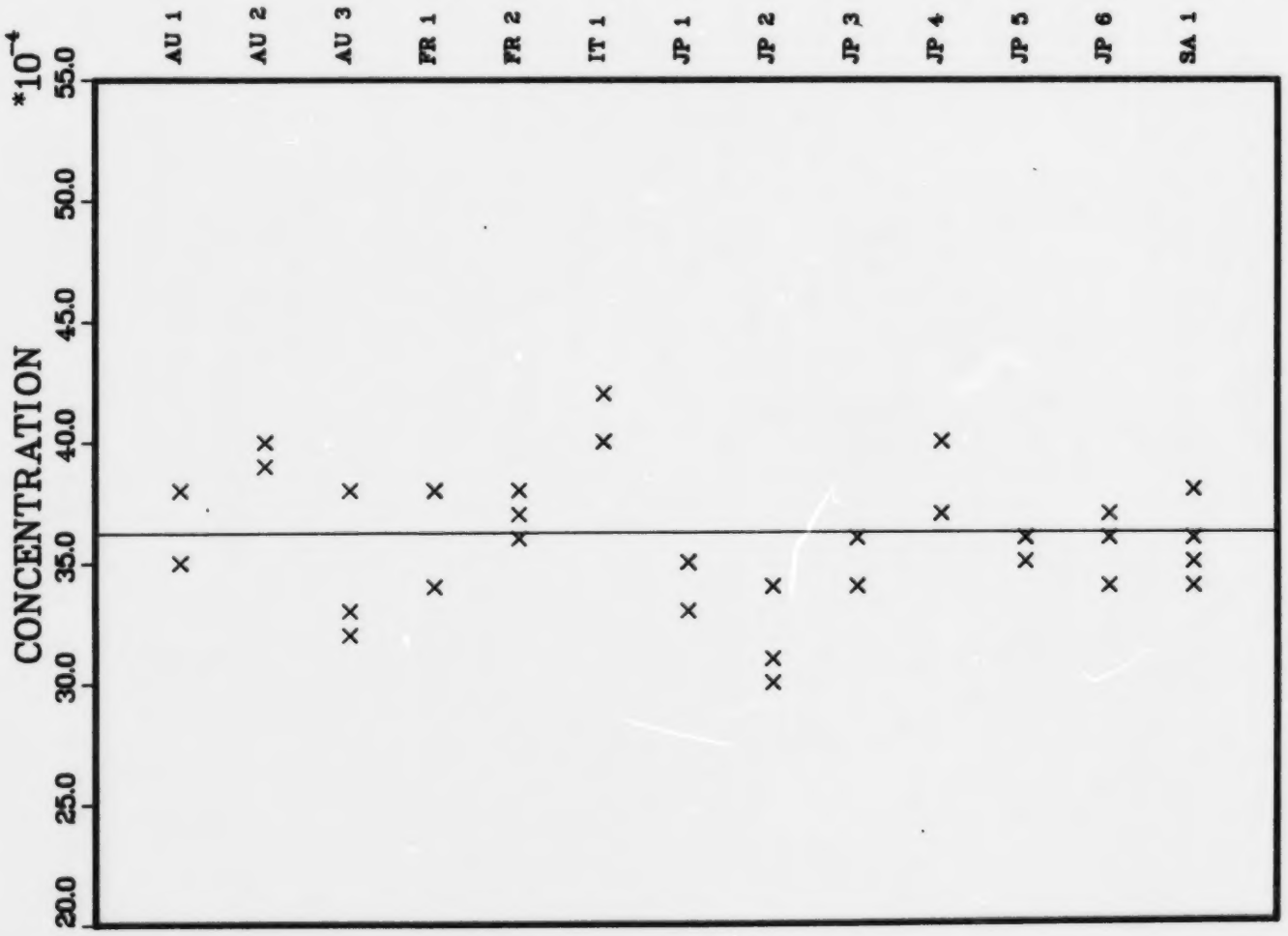

Figure 2.1 - Cr **ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM SAMPLE 79-6 (HAMERSLEY)**

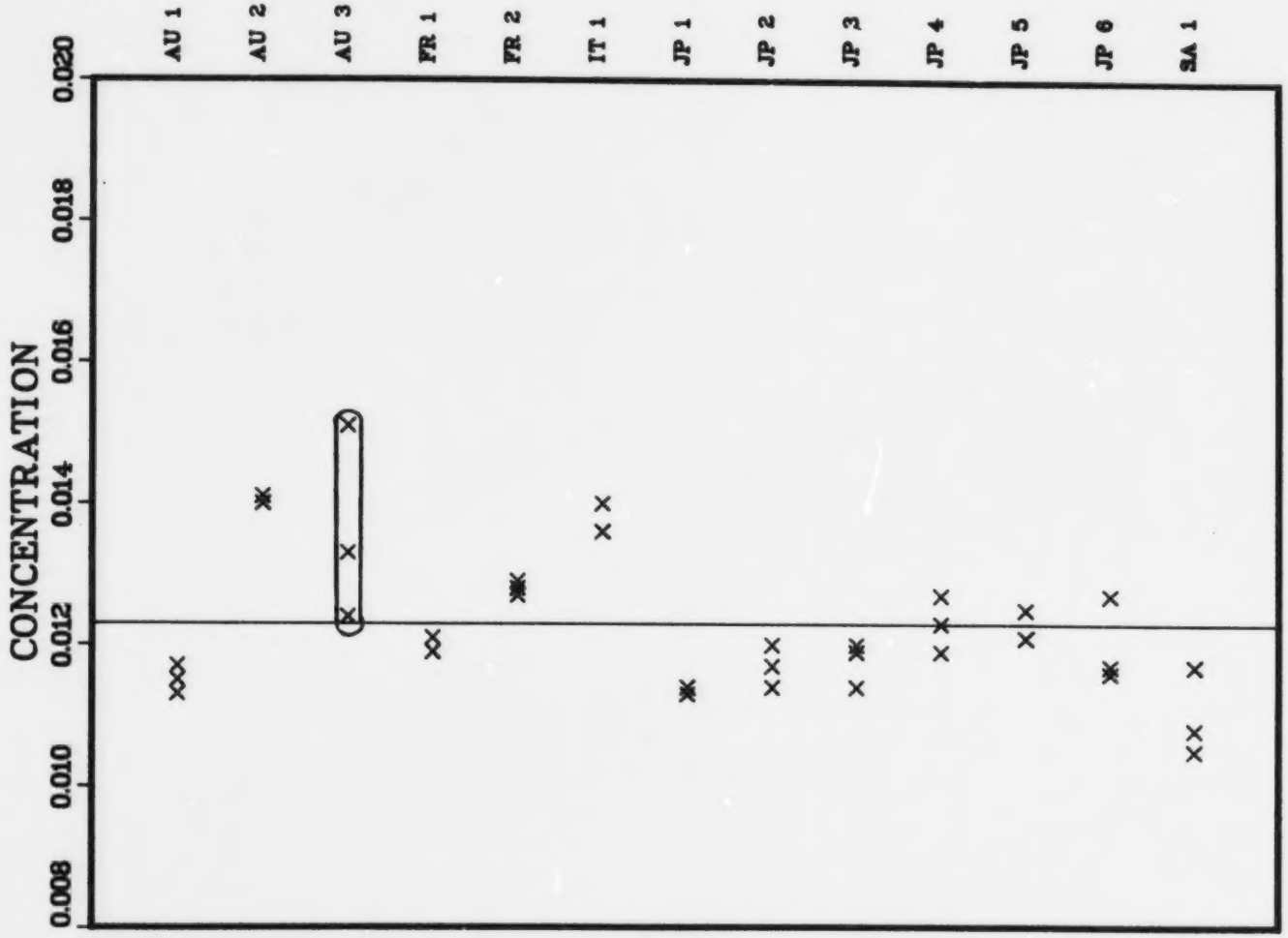

Figure 2.2 - Cr ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 76-17 (SAVAGE RIVER)

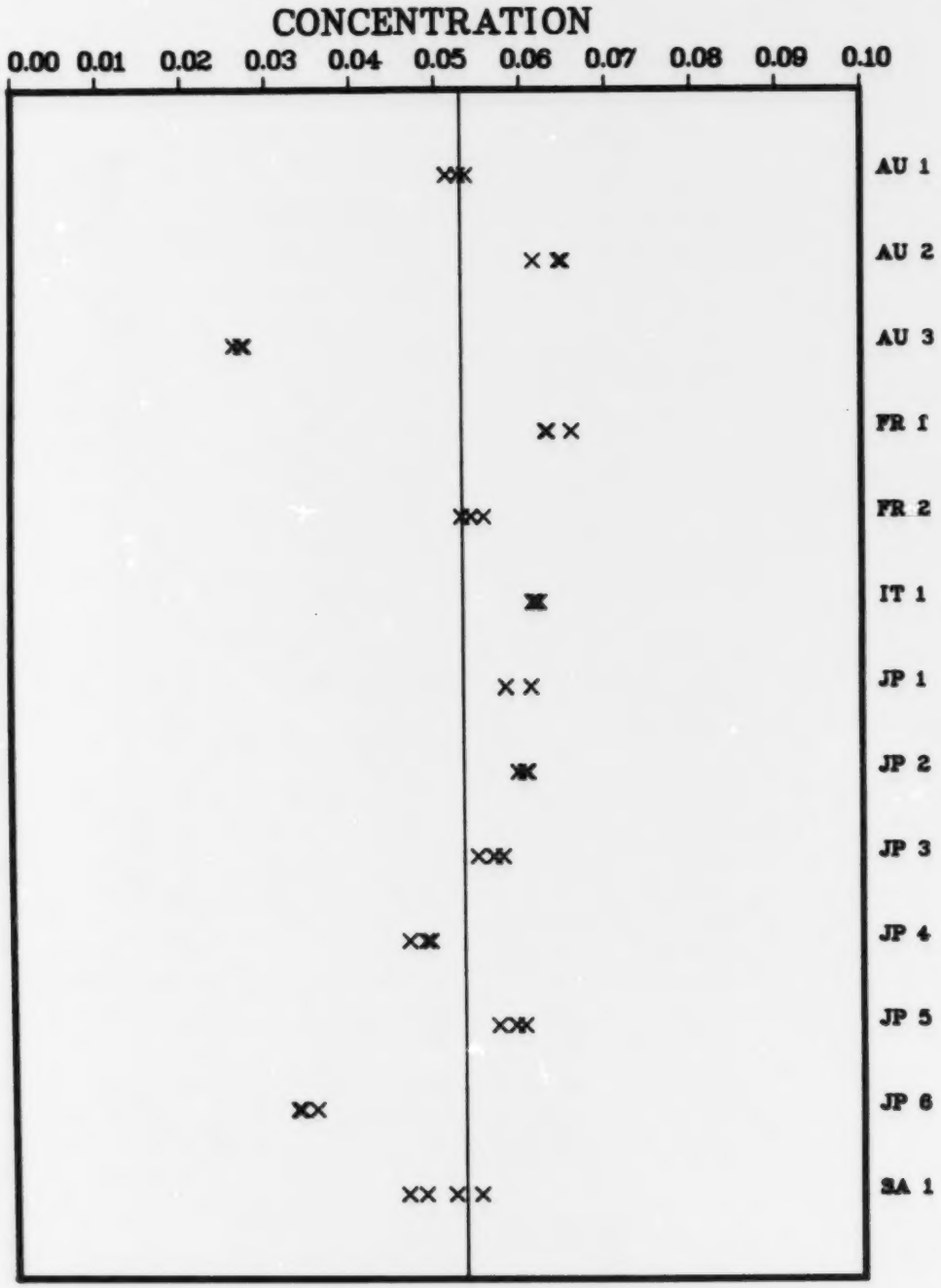

Figure 2.3 - Cr ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM SAMPLE 81-6 (SWAZILAND)

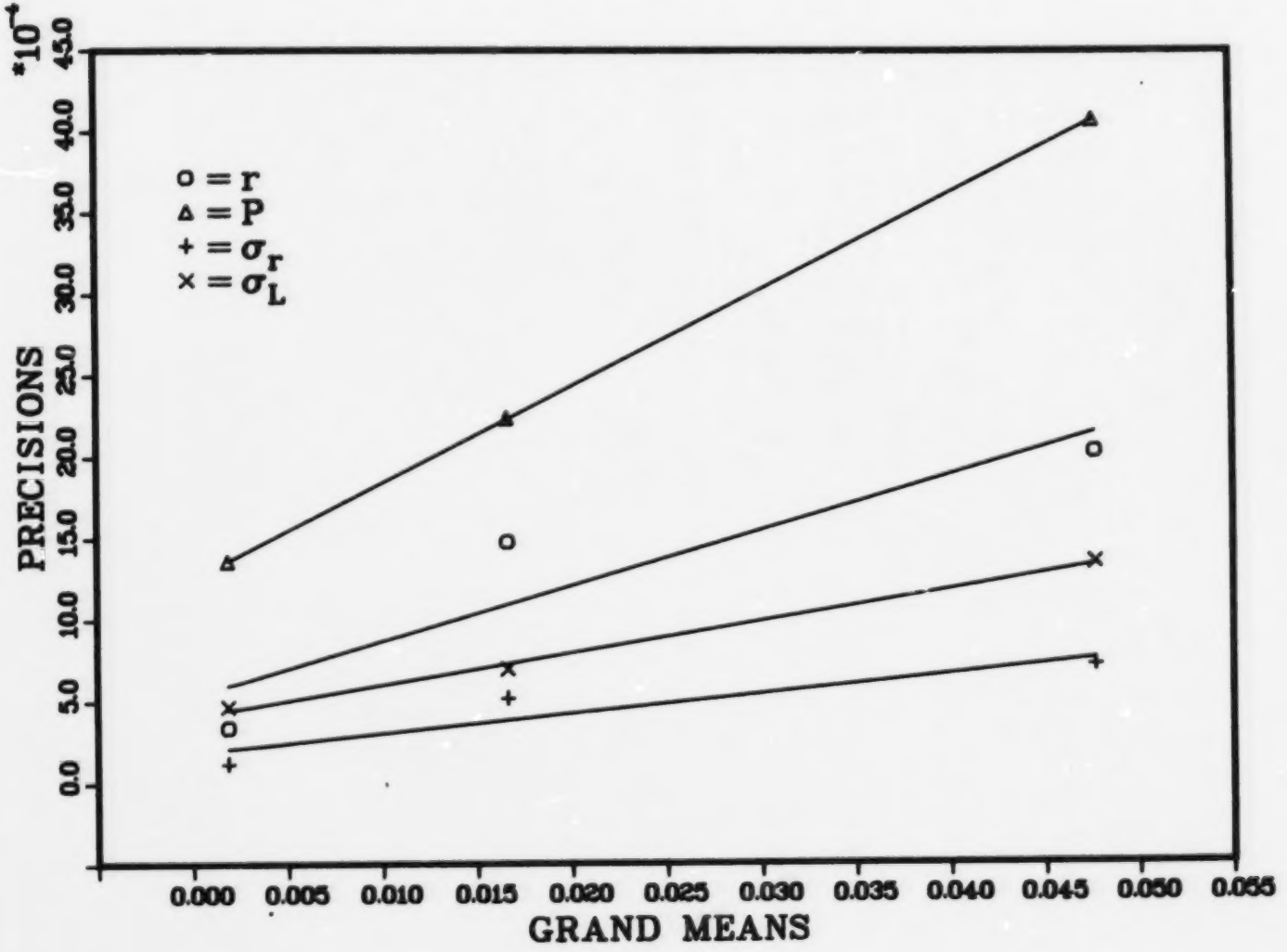

Figure 3.1 - Ni
ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL

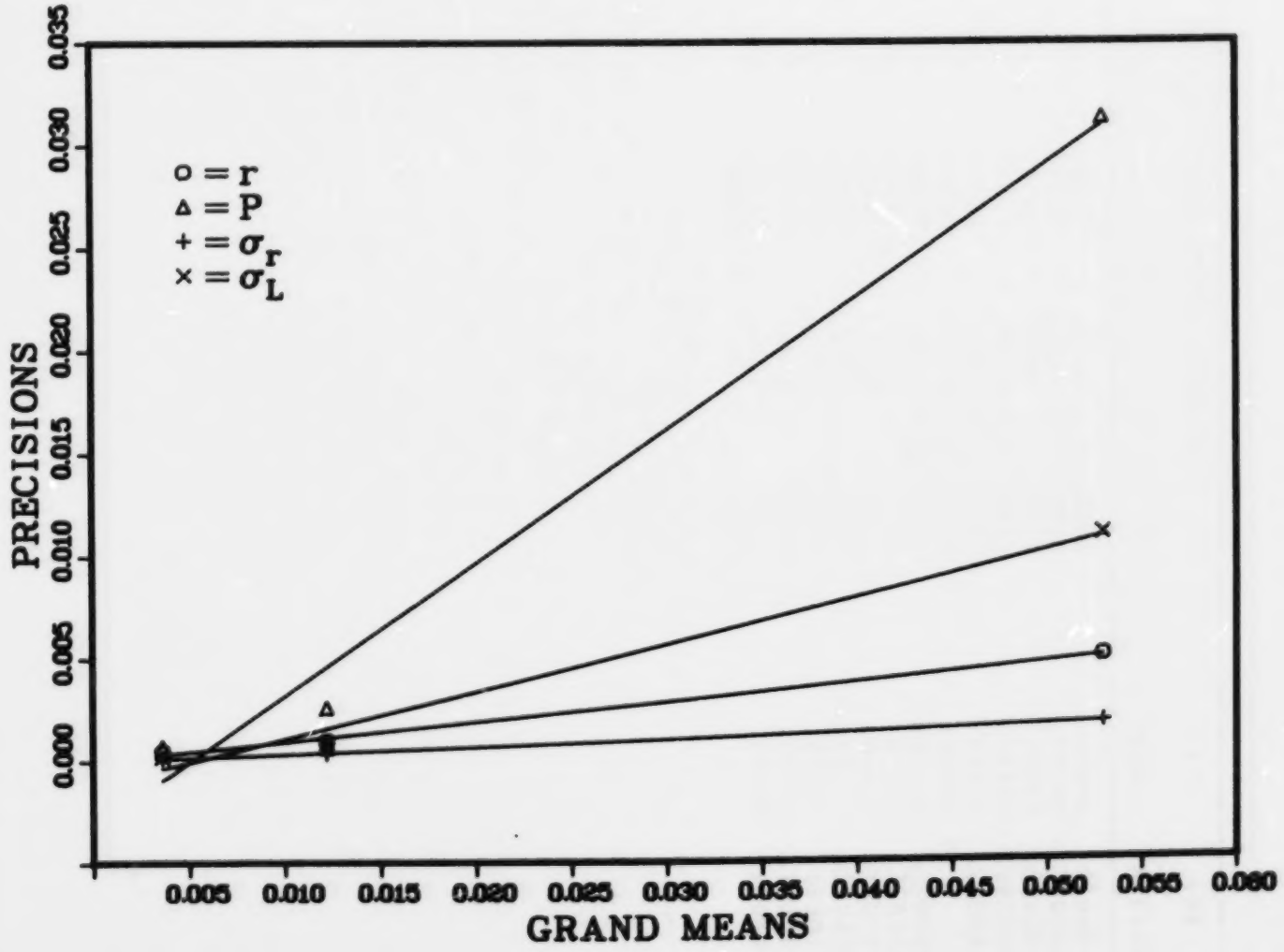

Figure 3.2 - Cr
ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM

APPENDIX A

Detailed computation of the analytical data

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 79-6 (HAMERSLEY)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0022	.0018	.0032	.00240	.5200E-06
2	AU 2	1	.0015	.0017	.0016	.00160	.1000E-07
3	AU 3	1	.0022	.0024	.0019	.00217	.6333E-07
4	FR 1	1	.0015	.0015	.0017	.00157	.1333E-07
5	FR 2	1	.0020	.0021	.0022	.00210	.1000E-07
6	IT 1	1	.0030	.0030	.0030	.00300	0.
7	JP 1	1	.0018	.0017	.0019	.00180	.1000E-07
8	JP 2	1	.0017	.0019	.0020	.00187	.2333E-07
9	JP 3	1	.0041	.0039	.0040	.00400	.1000E-07
10	JP 4	1	.0017	.0018	.0017	.00173	.3333E-08
11	JP 5	1	.0020	.0022	.0022	.00213	.1333E-07
12	JP 6	1	.0020	.0019	.0013	.00173	.1433E-06
13	SA 1	1	.0013	.0012	.0013	.00128	.2500E-08
			.0013				

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 79-6 (HAMERSLEY)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	28.693
CHI-SQUARE(.95,11)	19.681

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB- 1	C-CALC =	.632	C-CRIT(3,12) =	.392
LAB-12	C-CALC =	.474	C-CRIT(3,11) =	.417

DIXON'S TEST FOR LABORATORY MEANS

LAB- 9	R =	.667	D-CRIT(13) =	.611

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 1	COCHRAN'S TEST FOR LABORATORY VARIANCE
LAB- 9	DIXON'S TEST FOR LABORATORY MEANS
LAB-12	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 79-6 (HAMERSLEY)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	9	.64088441E-05	.71209379E-06
WITHIN LABS	21	.30083333E-06	.14325397E-07
TOTAL	30	.67096774E-05	

REPEATABILITY VARIANCE	.14325397E-07
REPEATABILITY STD. DEV.	.00011969
BETWEEN-LABORATORIES VARIANCE	.22532104E-06
BETWEEN-LABORATORIES STD. DEV.	.00047468
REPEATABILITY	.00033872
PERMISSIBLE TOLERANCE BETWEEN LABS	.00136453
GRAND MEAN	.00190323
VARIANCE OF THE GRAND MEAN	.23205233E-07

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 76-17 (SAVAGE RIVER)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0550	.0547	.0567	.05547	.1163E-05
2	AU 2	1	.0471	.0471	.0464	.04687	.1633E-06
3	AU 3	1	.0470	.0458	.0472	.04667	.5733E-06
4	FR 1	1	.0471	.0467	.0486	.04747	.1003E-05
5	FR 2	1	.0492	.0488	.0485	.04883	.1233E-06
6	IT 1	1	.0500	.0502	.0502	.05013	.1333E-07
7	JP 1	1	.0490	.0480	.0490	.04867	.3333E-06
8	JP 2	1	.0452	.0457	.0453	.04540	.7000E-07
9	JP 3	1	.0490	.0482	.0474	.04820	.6400E-06
10	JP 4	1	.0483	.0495	.0486	.04880	.3900E-06
11	JP 5	1	.0490	.0489	.0490	.04897	.3333E-08
12	JP 6	1	.0467	.0478	.0460	.04683	.8233E-06
13	SA 1	1	.0470 .0468	.0443	.0464	.04613	.1543E-05

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 76-17 (SAVAGE RIVER)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	19.212
CHI-SQUARE(.95,12)	21.030

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

LAB- 1 R = .739 D-CRIT(13) = .611

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 1 DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 76-17 (SAVAGE RIVER)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.67108896E-04	.61008088E-05
WITHIN LABS	25	.12900833E-04	.51603333E-06
TOTAL	36	.80009730E-04	

REPEATABILITY VARIANCE	.51603333E-06
REPEATABILITY STD. DEV.	.00071835
BETWEEN-LABORATORIES VARIANCE	.18126026E-05
BETWEEN-LABORATORIES STD. DEV.	.00134633
REPEATABILITY	.00203294
PERMISSIBLE TOLERANCE BETWEEN LABS	.00407227
GRAND MEAN	.04770270
VARIANCE OF THE GRAND MEAN	.16621076E-06

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 81-6 (SWAZILAND)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0189	.0177	.0170	.01787	.9233E-06
2	AU 2	1	.0161	.0159	.0161	.01603	.1333E-07
3	AU 3	1	.0149	.0154	.0158	.01537	.2033E-06
4	FR 1	1	.0173	.0172	.0179	.01747	.1433E-06
5	FR 2	1	.0171	.0173	.0172	.01720	.1000E-07
6	IT 1	1	.0200	.0204	.0204	.02027	.5333E-07
7	JP 1	1	.0162	.0164	.0164	.01633	.1333E-07
8	JP 2	1	.0164	.0161	.0156	.01603	.1633E-06
9	JP 3	1	.0175	.0169	.0183	.01757	.4933E-06
10	JP 4	1	.0167	.0167	.0165	.01663	.1333E-07
11	JP 5	1	.0175	.0170	.0171	.01720	.7000E-07
12	JP 6	1	.0160	.0161	.0163	.01613	.2333E-07
13	SA 1	1	.0154 .0173	.0169	.0156	.01630	.8867E-06

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 81-6 (SWAZILAND)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	25.219
CHI-SQUARE(.95,12)	21.030

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

NONE REJECTED

DIXON'S TEST FOR LABORATORY MEANS

LAB- 6 R = .638 D-CRIT(13) = .611

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 6 DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - NICKEL
SAMPLE: 81-6 (SWAZILAND)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.19581081E-04	.17800983E-05
WITHIN LABS	25	.68000000E-05	.27200000E-06
TOTAL	36	.26381081E-04	

REPEATABILITY VARIANCE	.27200000E-06
REPEATABILITY STD. DEV.	.00052154
BETWEEN-LABORATORIES VARIANCE	.48947049E-06
BETWEEN-LABORATORIES STD. DEV.	.00069962
REPEATABILITY	.00147595
PERMISSIBLE TOLERANCE BETWEEN LABS	.00223815
GRAND MEAN	.01666757
VARIANCE OF THE GRAND MEAN	.48468303E-07

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 79-6 (HAMERSLEY)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0035	.0035	.0038	.00360	.3000E-07
2	AU 2	1	.0039	.0040	.0040	.00397	.3333E-08
3	AU 3	1	.0038	.0033	.0032	.00343	.1033E-06
4	FR 1	1	.0038	.0034	.0038	.00367	.5333E-07
5	FR 2	1	.0037	.0038	.0036	.00370	.1000E-07
6	IT 1	1	.0040	.0042	.0040	.00407	.1333E-07
7	JP 1	1	.0035	.0035	.0033	.00343	.1333E-07
8	JP 2	1	.0031	.0034	.0030	.00317	.4333E-07
9	JP 3	1	.0034	.0034	.0036	.00347	.1333E-07
10	JP 4	1	.0040	.0040	.0037	.00390	.3000E-07
11	JP 5	1	.0036	.0036	.0035	.00357	.3333E-08
12	JP 6	1	.0037	.0036	.0034	.00357	.2333E-07
13	SA 1	1	.0036	.0034	.0038	.00358	.2917E-07
			.0035				

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 79-6 (HAMERSLEY)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	9.042
CHI-SQUARE(.95,12)	21.030

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 79-6 (HAMERSLEY)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.21422500E-05	.17852083E-06
WITHIN LABS	27	.76750000E-06	.28425926E-07
TOTAL	39	.29097500E-05	

REPEATABILITY VARIANCE	.28425926E-07
REPEATABILITY STD. DEV.	.00016860
BETWEEN-LABORATORIES VARIANCE	.48811352E-07
BETWEEN-LABORATORIES STD. DEV.	.00022093
REPEATABILITY	.00047714
PERMISSIBLE TOLERANCE BETWEEN LABS	.00071046
GRAND MEAN	.00362250
VARIANCE OF THE GRAND MEAN	.44935279E-08

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 76-17 (SAVAGE RIVER)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0115	.0113	.0117	.01150	.4000E-07
2	AU 2	1	.0141	.0140	.0140	.01403	.3333E-08
3	AU 3	1	.0151	.0124	.0133	.01360	.1890E-05
4	FR 1	1	.0121	.0119	.0119	.01197	.1333E-07
5	FR 2	1	.0128	.0129	.0127	.01280	.1000E-07
6	IT 1	1	.0140	.0136	.0136	.01373	.5333E-07
7	JP 1	1	.0113	.0114	.0114	.01137	.3333E-08
8	JP 2	1	.0120	.0117	.0114	.01170	.9000E-07
9	JP 3	1	.0119	.0120	.0114	.01177	.1033E-06
10	JP 4	1	.0123	.0127	.0119	.01230	.1600E-06
11	JP 5	1	.0125	.0121	.0121	.01223	.5333E-07
12	JP 6	1	.0127	.0116	.0117	.01200	.3700E-06
13	SA 1	1	.0117	.0105	.0117	.01118	.3825E-06
			.0108				

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 76-17 (SAVAGE RIVER)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	32.277
CHI-SQUARE(.95,12)	21.030

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB- 3 C-CALC = .596 C-CRIT(3,13) = .370

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 3 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 76-17 (SAVAGE RIVER)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.27595743E-04	.25087039E-05
WITHIN LABS	25	.29475000E-05	.11790000E-06
TOTAL	36	.30543243E-04	

REPEATABILITY VARIANCE	.11790000E-06
REPEATABILITY STD. DEV.	.00034337
BETWEEN-LABORATORIES VARIANCE	.77596268E-06
BETWEEN-LABORATORIES STD. DEV.	.00088089
REPEATABILITY	.00097172
PERMISSIBLE TOLERANCE BETWEEN LABS	.00258587
GRAND MEAN	.01218649
VARIANCE OF THE GRAND MEAN	.68369619E-07

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 81-6 (SWAZILAND)

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0527	.0513	.0536	.05253	.1343E-05
2	AU 2	1	.0649	.0645	.0615	.06363	.3453E-05
3	AU 3	1	.0263	.0272	.0275	.02700	.3900E-06
4	FR 1	1	.0631	.0629	.0659	.06397	.2813E-05
5	FR 2	1	.0540	.0529	.0555	.05413	.1703E-05
6	IT 1	1	.0620	.0615	.0612	.06157	.1633E-06
7	JP 1	1	.0610	.0580	.0580	.05900	.3000E-05
8	JP 2	1	.0606	.0594	.0603	.06010	.3900E-06
9	JP 3	1	.0576	.0565	.0546	.05623	.2303E-05
10	JP 4	1	.0465	.0485	.0490	.04800	.1750E-05
11	JP 5	1	.0570	.0601	.0590	.05870	.2470E-05
12	JP 6	1	.0335	.0338	.0357	.03433	.1423E-05
13	SA 1	1	.0483	.0518	.0548	.05028	.1444E-04
			.0462				

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 81-6 (SWAZILAND)

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	14.358
CHI-SQUARE(.95,12)	21.030

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21A - NI/CR AAS METHOD - CHROMIUM
SAMPLE: 81-6 (SWAZILAND)

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.44907336E-02	.37422780E-03
WITHIN LABS	27	.85714167E-04	.31745988E-05
TOTAL	39	.45764478E-02	

REPEATABILITY VARIANCE	.31745988E-05
REPEATABILITY STD. DEV.	.00178174
BETWEEN-LABORATORIES VARIANCE	.12066771E-03
BETWEEN-LABORATORIES STD. DEV.	.01098489
REPEATABILITY	.00504233
PERMISSIBLE TOLERANCE BETWEEN LABS	.03129102
GRAND MEAN	.05296750
VARIANCE OF THE GRAND MEAN	.94311123E-05